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NOISE ELEMENT
OF THE ALAMEDA COUNTY GENERAL PLAN

Alameda County Planning Commission
July 31, 1975
Revised September 29, 1975

4 - NOISE ELEMENT

I. INTRODUCTION

Noise, for the purposes of the Noise Element, may be briefly defined as unwanted sound. Increasing urbanization and greater volumes of traffic are creating noise problems which adversely affect the quality of the environment for both humans and animals. Although sounds that are pleasant to one person may be noise to another person, it is recognized that excessive sound can be physiologically and psychologically harmful for man and beast. Federal, state, and local governments and private industry are presently involved in attempts to achieve noise reduction through source emission reduction, improved highway design, and land use control.

II. BACKGROUND

Authority:

Under Section 65302 (g) of the California Government Code, all counties and cities in the State must prepare a noise element to their general plans, as follows:

> A noise element in quatitative, numerical terms, showing contours of present and projected noise levels associated with all existing and proposed major transportation elements. These include but are not limited to the following:
>
> 1. Highways and freeways
> 2. Ground rapid transit systems
> 3. Ground facilities associated with all airports operating under a permit from the State Department of Aeronautics.

All agencies, public and private, who are responsible for the construction and maintenance of such transportation facilities are to provide to the local agency producing the noise element of the general plan a statement of the present and projected noise levels of the facility and any information that was used in the development of such levels.

Sources of Noise:

Noise is produced by transportation vehicles, the operation of machinery, radios, and other forms of human activity. It is generally recognized that noise from transportation vehicles has had the most significant effect on the quality of the urban environment. Transportation noise sources are governed by many factors such as: (a) the design, construction, maintenance, and manner of operating a vehicle, and (b) the path that the sound waves travel to meet the observer-distance, obstructions, reflections off surfaces, etc.

Definition of Noise and Methods of Measurement:

> Noise is usually defined as unwanted sound. One person's music may be nothing but noise to another. For example, the sound of rock music from your teenager's hi-fi may be music to him or her, but noise to you if you are trying to converse or relax in an adjoining room. To describe

noise and its effects on people in a quantitative way, we must include human factors related to the way we perceive noise. These factors include differences in the way our ears hear sounds at different frequencies, whether the sound contains any irritating "screech," such as squeaky chalk on the blackboard, and how long the sound lasts. Applying all these factors enables us to translate from a physical measurement of a sound to its value on a subjective scale.

Sound travels through the air in the form of small waves of tiny air pressure fluctuations. (these waves are similar to the circular waves of motion seen on the surface of the water when a stone is dropped into a pool.) Sound is measured by letting these air pressure fluctuations strike a microphone, and then measuring the electrical signal produced by the microphone. A complete description of the sound must include the magnitude of the pressure at the audible frequencies contained in the sound, and the way the magnitude and frequencies change with time.[1]

Sound levels are commonly measured in units called decibels (dB), and these units are used in a logarithmic scale to define noise according to the perceptions of the human ear. A sound level of zero decibels (0 dB) is the weakest sound normal human ears can detect. Because the scale is logarithmic, a sound ten times more intense than a 0 dB sound has a sound level of 10 dB. A sound 100 times greater than 0 dB has a sound level of 20 dB. In terms of loudness, a sound which is measured as being ten times more intense than another (10 dB higher) is perceived by the human ear as being twice as loud, not ten times as loud.

When combining two sounds, each with equal sound levels, the sum of the sounds is not twice the original level but the original level plus 3 dB. The resulting sound pressure level in decibels from the combined sources would be 3 dB higher than the level produced by either source alone. When combining significantly different sound levels (10 dB or more between the two), the sum is a level not significantly different from that produced by the greater source alone. This is illustrated in Figure 1. Applying this concept to community noise reduction means that the loudest sounds must be quieted in order to achieve real reductions in ambiant levels.

Because of the complex way in which the ear works, strict measurement of noises does not always correlate with their relative loudness of annoyance. Consequently, different scales have been developed to aid in evaluating the importance of different noise sources. Sound, and noise, is usually a variable quantity in the environment. Sounds have variable levels and frequencies, and both of these variables may change with time. The precise measurement of all these variables becomes so complex that the general usefulness is lost except for some scientific purposes. A way is needed to make accurate, comparable measurements of sounds which are related to the effects of those sounds on the human ear.

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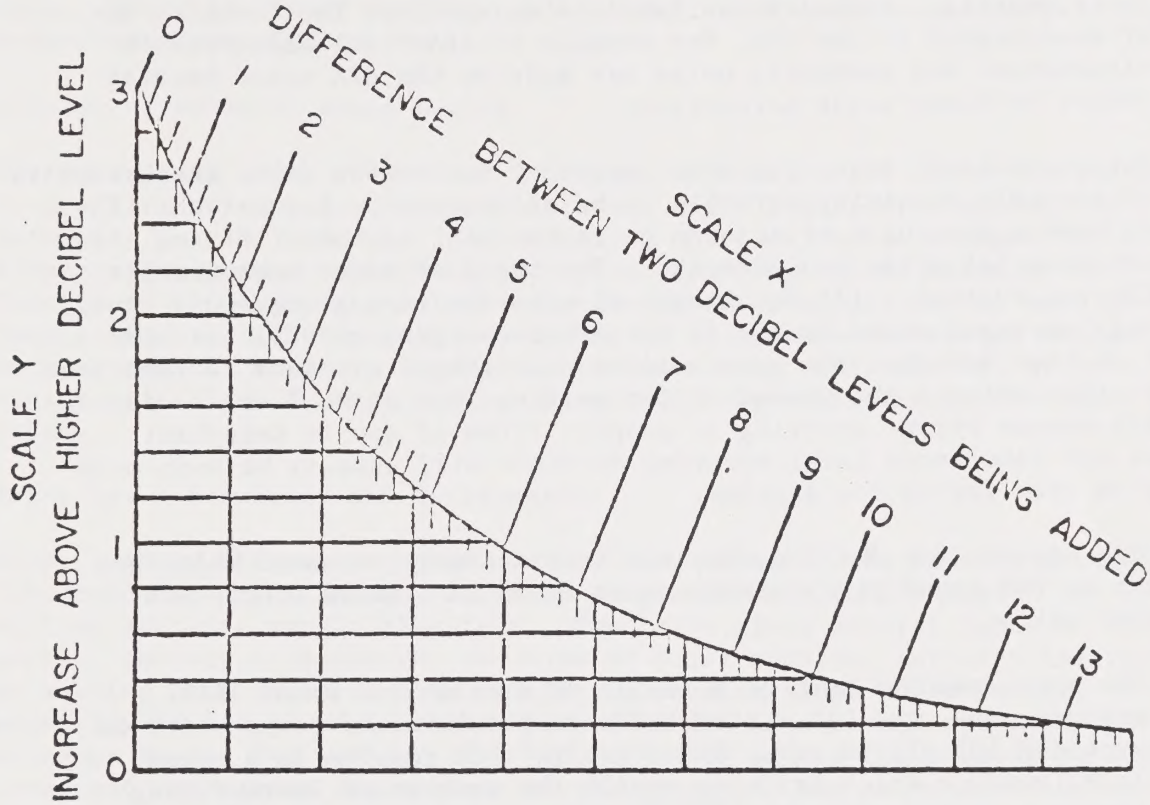
[1] U.S. Department Transportation, Transportation Noise and Its Control (June, 1972), p. 19.

FIGURE 1

CHART FOR COMBINING LEVELS OF UNCORRELATED SOUNDS



The combined noise of a truck (90 dB) and a bus (84 dB) can be calculated in the following manner:

1. Determine the difference in levels (6 dB).
2. Locate 6 dB on Scale X.
3. Read directly across to the left-hand scale (Y) to the answer (approximately 1.0 dB).
4. Add this amount to the higher noise, the truck noise (90 dB + 1.0 dB = 91.0 dB).

The aggregate of these two noise sources is 91 dB.

Source: Measurement of Noise, County of Santa Clara Planning Department, October 1972.

For most purposes, the variable of sound frequency has been eliminated by using a weighting which accounts for the frequency response of the human ear. The human ear is more sensitive to mid-frequency sounds than it is to both high and low frequency sounds. The "A" scale weighting on a sound level meter accounts for the frequency response of the human ear in its measurements and frequency is thus eliminated as a variable in common sound measurements. When a sound level is measured on the A scale, the unit of measurement is the dBA, for example 45 dBA. All measurements of environmental and community noise are made on the dBA scale because they relate to human noise perceptions.

With the sound level being the most important factor for sound measurements, time is the only remaining variable to be eliminated by assumption. There has not been a unanimity of opinion as to the best method of fixing time for environmental noise measurements. Two types of noise measurements are affected by time: (1) the length of exposure to a given sound level, or energy averaged sound level, if the level changes; and (2) the time in the 24 hour day that the sound occurs. Length of exposure is important because this effects the potential for hearing loss as well as the degree to which sounds become annoying to people. Time of day is important because the same sound level occuring at night will usually be much more offensive than during the daytime.

The three systems for dealing with the time variable in sound which are relevant to the sound level measurements taken in Alameda County are presented below:

L_{10}: The most commonly used of a family of statistical sound level measurements, the L_{10} system reflects the level of sound which is exceeded 10% of the time. Intuitively, this results in a sound level measure which reflects nearly the peak sound level during the test period, excluding the top 10% of the noise level as unrepresentative. The L_{10} system used in the California Department of Transportation[1] work was measured at the loudest one hour period of the morning or evening commute. No attempt was made to present noise levels with respect to the different times of day.

L_{dn}: The L_{dn} system of sound level measurement attempts to show a composite. 24 hour representation of the sound level. The exact definition of L_{dn} is complex[2] but it is generally a 24 hour sound measurement which adds a 10 dBA penalty to sounds produced between the night time hours of 10 p.m. and 7 a.m. the next day. Sound levels of this type are sometimes called community sound levels. Bay Area Rapid Transit District, Western Pacific Railroad and the Southern Pacific Transportation Company sound level data will all be in the L_{dn} system.

CNEL: A method very similar to the L_{dn} method, CNEL is a complex expression of community noise levels[2].

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[1] Formerly California State Division of Highways.
[2] See glossary.

The only difference between L_{dn} and CNEL is that CNEL divides the 24 hour day into three parts and uses slightly different penalties. The CNEL system adds a 5 dBA penalty to sounds produced between 7 p.m. and 10 p.m. and a 10 dBA penalty on sounds between 10 p.m. and 7 a.m. the next day. The results of CNEL and L_{dn} measurements may be compared directly with an insignificant loss of accuracy. L_{10} measurements cannot be compared with L_{dn} or CNEL data. Noise levels of the Metropolitan Oakland International Airport are presented in the CNEL system.

Effects of Noise on Human Health:

The effects of noise on man are the basic motivation for understanding and controlling noise. At the upper extreme, noise can cause temporary or permanent loss of hearing. Additionally, noise may cause changes in cardiovascular, gastro-intestinal, endocrine, neurologic, and other physiologic functions, although the medical evidence is not conclusive. At much lower levels of noise, the unwanted sound begins to obscure the wanted sounds such as speech, music or signals; when discussing environmental or community noise levels, this problem of activity interference is the major issue.

Noise Level Standards and References:

Table 1 shows the sound (noise) levels identified by the Federal Environmental Protection Agency (EPA) as requisite to protect the public health and welfare with an adequate margin of safety. The table gives several land use categories, indoors or outdoors, and type of noise problem, activity interference or hearing loss, as factors in specifying problematical noise levels. The noise levels are given in either the L_{dn} noise measurement system explained above or in the L_{eq} system. The L_{eq} method is called the equivalent sound level and represents the average of the <u>energy</u> in the sound over the specified time period. The specified time period is the number in parentheses immediately after the L_{eq}, for example, L_{eq} (24). It should be restated that the energy in sound increases many times faster than the decibel level; louder sounds are counted more heavily in the L_{eq} system than are quieter sounds.

Figure 2 shows information similar to that in Table 1 but from a different source and in another sound measuring system. The noise levels for each land use category were selected in the ABAG sponsered Regional Airport Systems Study and converted from the NEF system to CNEL. The figure gives another interpretation of desirable noise levels similar to the levels of Table 1. (L_{dn} and CNEL are approximately comparable)

Effective August, 1974, the Alameda County Building Code includes specifications for noise levels inside and outside of any new notels, motels, apartment houses, and attached dwellings. These specifications are contained in Section 3502, Noise Insulation from Exterior Sources". The ordinance adopted a standard of an annual CNEL of 45 dB inside all new residential construction. Further, any proposed residential construction within a CNEL contour of 60 dB requires an acoustical analysis showing that the structure has been designed to limit intruding noise to the prescribed allowable level (45 dB). Noise sources considered are proposed and existing airports, rapid transit systems, railroads, highways, freeways, etc.

Table 1

YEARLY AVERAGE* EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

	Measure	Indoor Activity Interference	Indoor Hearing Loss Consideration	To Protect Against Both Effects (b)	Outdoor Activity Interference	Outdoor Hearing Loss Consideration	To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)(d)}$	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)(d)}$		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity. (See Figure D-2 for noise levels as a function of distance which allow satisfactory communication.)
b. Based on lowest level.
c. Based only on hearing loss.
d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years.

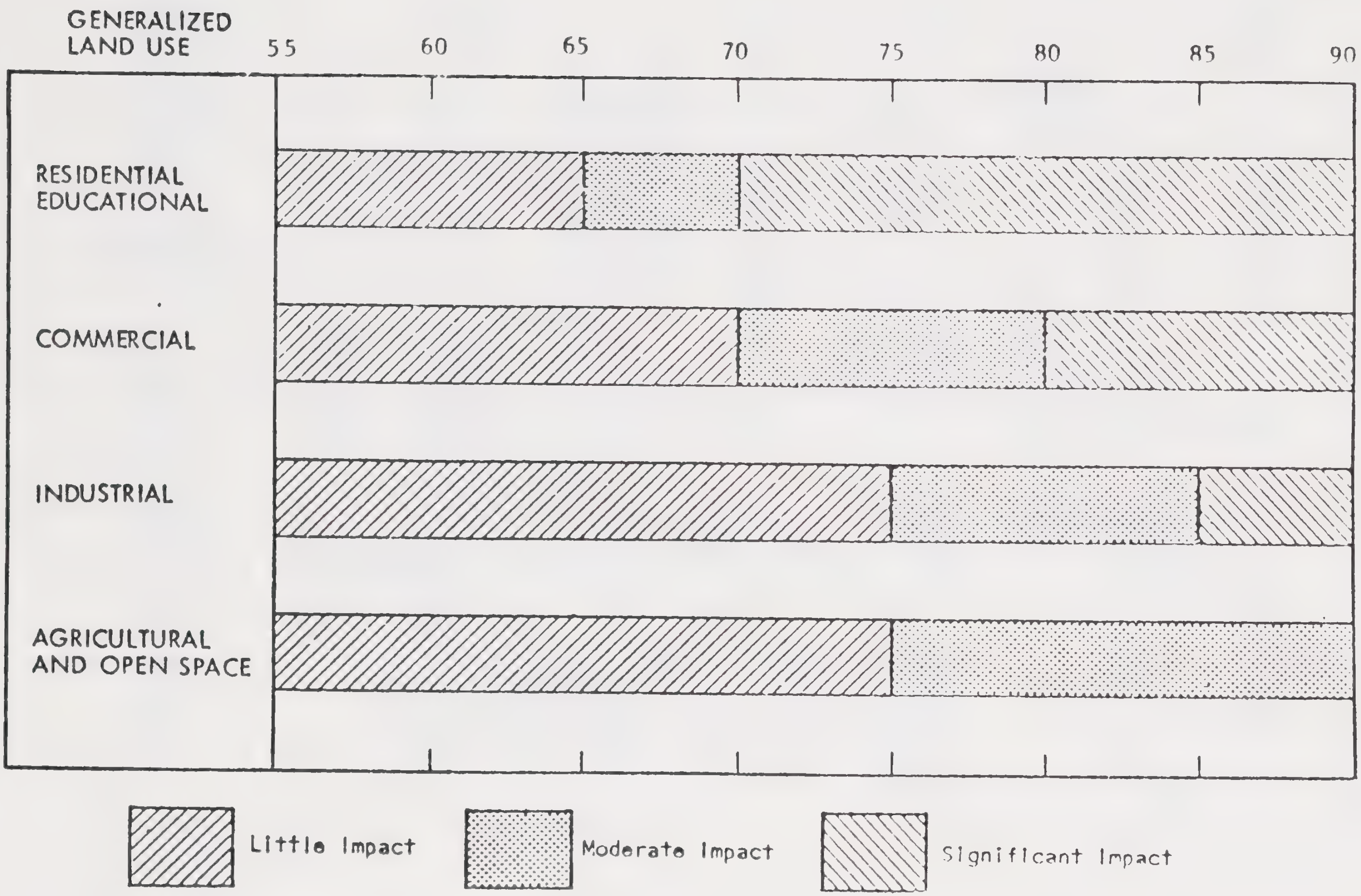
*Refers to energy rather than arithmetic averages.

Source: U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (March, 1974), p. 29.

Figure 2

SIMPLIFIED LAND USE INTERPRETATIONS OF COMMUNITY EQUIVALENT LEVEL NOISE EXPOSURE

APPROXIMATE CNEL VALUE (d BA)

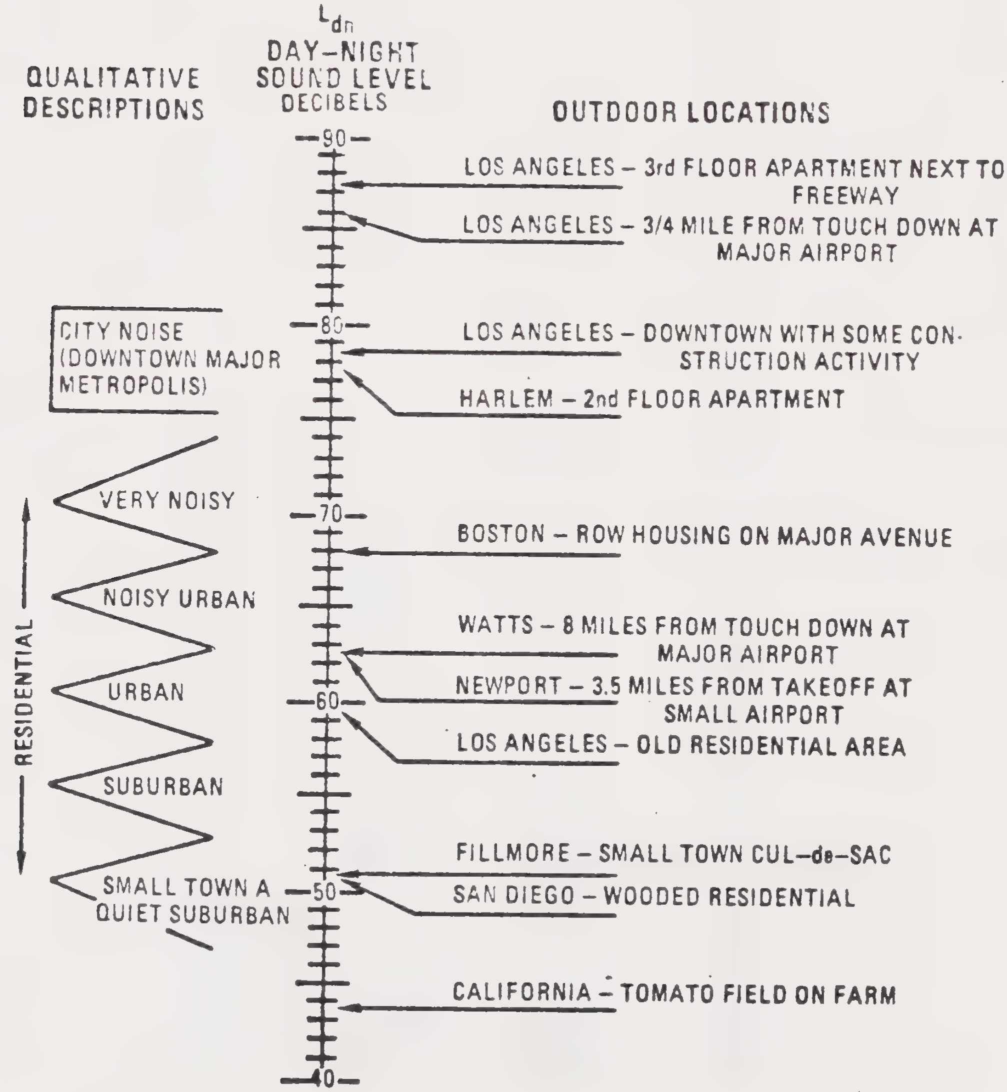


Source: Adopted from Regional Airport Systems Study, Final Plan (June, 1972), by Alameda County Planning Department, July, 1975.

As a qualitative reference, Figure 3 shows some typical community noise level measurements for different outdoor locations. Table 2 also correlates decibel levels with familar sounds.

Figure 3

OUTDOOR DAY-NIGHT SOUND LEVEL IN dB AT VARIOUS LOCATIONS



Source: U.S. Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (March, 1974), p. 14.

TABLE 2

SOUND LEVEL AND LOUDNESS OF TYPICAL SOUNDS
IN INDOOR AND OUTDOOR ENVIRONMENTS

dBA	SUBJECTIVE IMPRESSION	COMMUNITY* (Outdoor)	HOME OR INDUSTRY* (Indoor)	RELATIVE LOUDNESS (Human Judgment of Different Sound Levels)
130	Painful	Military Jet Aircraft Take-Off With After-Burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	32 Times as Loud
120	Uncomfortably Loud	Turbo-Fan Aircraft @ Take-Off Power @ 200 Ft. (118)	Rock-N-Roll Band (108-114)	16 Times as Loud
110		Jet Flyover @ 1000 Ft. (103) Boeing 707, DC-8 @ 6080 Ft. Before Landing (106), Bell J-2A Helicopter @ 100 Ft. (100)		8 Times as Loud
100	Very Loud	Boeing 737, DC-9 @ 6080 Ft. Before Landing (97), Motorcycle @ 25 Ft. (90)	Newspaper Press (97)	4 Times as Loud
90		Car Wash @ 20 Ft. (89), Prop. Plane Flyover @ 1000 Ft. (88), Diesel Truck, 40 MPH @ 50 Ft. (84), Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85)	2 Times as Loud
80				

*Numbers in parenthesis are A-Levels

(CONTINUED NEXT PAGE)

TABLE 2 (Contd.)

dBA	SUBJECTIVE IMPRESSION	COMMUNITY* (Outdoor)	HOME OR INDUSTRY* (Indoor)	RELATIVE LOUDNESS (Human Judgment of Different Sound Levels)
80	Moderately Loud	High Urban Ambient Sound (80), Passenger Car, 65 MPH @ 25 Ft. (77), Freeway @ 50 Ft. from Pavement Edge, 10 a.m. (76±6)	TV-Audio, Vacuum Cléaner (70)	REFERENCE LOUDNESS 70 dBA
70		Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70), Electric Typewriter @ 10 Ft. (64), Dishwasher (Rinse) @ 10 Ft. (60), Conversation (60)	1/2 as Loud
60	Quiet	Large Transformers @ 100 Ft. (50)		1/4 as Loud
50		Bird Calls (44), Lower Limit Urban Ambient Sound (40)		1/8 as Loud
40	Just Audible	(dBA Scale Interrupted)		
10	Threshold of Hearing			
0				

Source: HUD Noise Assessment Guidelines Technical Background, Bolt, Beranek and Newman, Inc., December 1971.

Cities within Alameda County have provided input to [illegible] County Noise Element during the preparations and hearing stages. In addition the County, at the request of the City Managers is investigating means of providing a continuing data base on noise for use of all jurisdictions within the County.

Airport Land Use Commission (ALUC):

The Alameda County Airport Land Use Commission staffed by the Alameda County Planning Department consists of seven members and has a basic assignment of formulating a comprehensive, long range plan for each airport and its surroundings so as to provide for orderly growth of the airport and airport planning area, to safeguard the general welfare of the inhabitants in the County and the public in general. Within the airports planning area the Commissioners may determine standards, including soundproofing adjacent to airports.

California Airport Noise Standards[1]

In 1969, the California Public Utilities Code was amended, directing the Division of Aeronautics to

> "...adopt noise standards governing the operation of aircraft and aircraft engines for airports operating under a valid permit issued by the department (division) to an extent not prohibited by federal law. The standards shall be based upon the level of noises acceptable to a reasonable person residing in the vicinity of the airport."

The legislation stated that:

> "Statewide uninformity in standards of acceptable airport noise need not be required, and the maximum amount of local control and enforcement shall be permitted.
>
> Due consideration shall be given to the economic and technological feasibility of complying with the standards promulagated".

Implementation of the legislation has been slow due to the requirement for complex and expensive noise monitoring systems at noise problem airports.

Airport Noise Standards, in the California Administrative Code (1970) are measured in CNEL with 65 dB as the level of noise acceptable to a reasonable person residing in the vicinity of an airport.

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[1] Source: <u>An Investigative Study of California Experience in Airport Noise Regulation</u>, Harrison C. Dunning. Final Report to Environmental Protection Agency, June 12, 1975.

III. Noise Levels in Alameda County

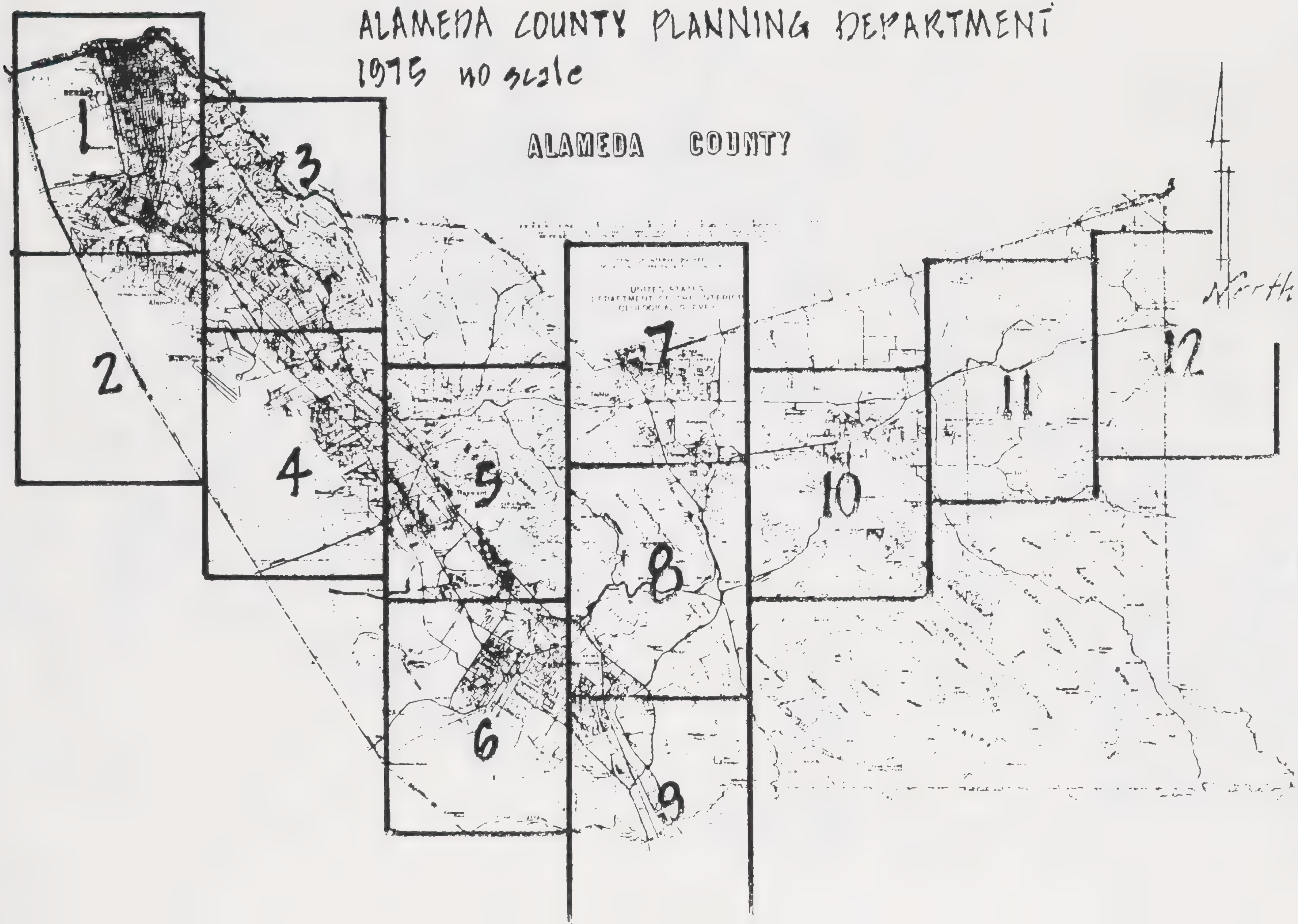
The existing noise environment in Alameda County is the result of many noise sources, however, transportation systems are the largest single contributor. Noise contours, representing lines of equal sound/noise levels, have been shown adjacent to selected transportation facilities in the County. For purposes of clarity, only the lower level contours have been shown for most transportation facilities.[1] Generally, the projected noise contours are based on the existing conditions and the assumptions on growth of the particular facility. Not all of the noise levels are projected to the same year.

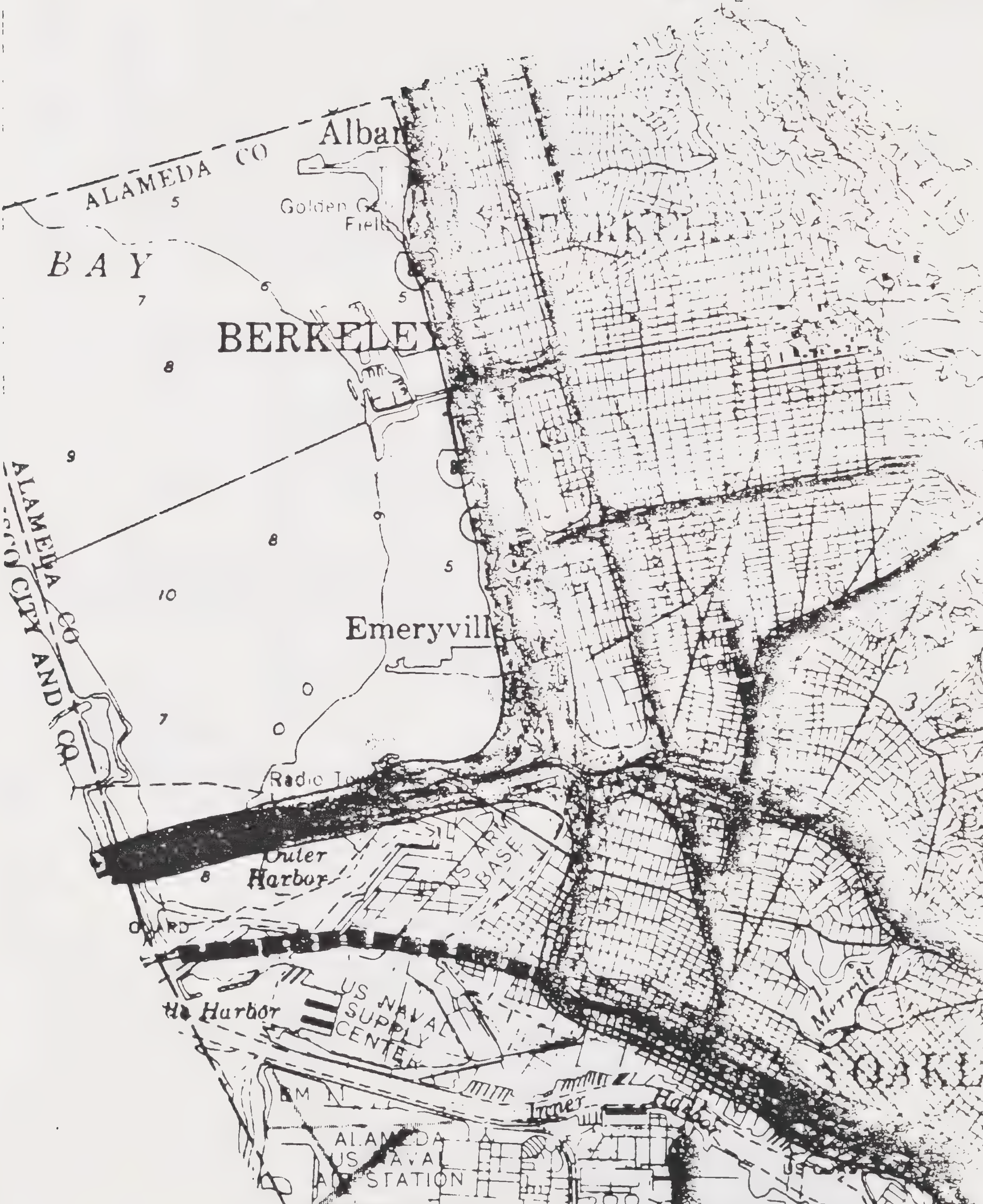
This section contains maps of 65 dB CNEL, L_{dn}, or L_{10} noise contours for major highways and BART. The scale of these maps is 1" to 62,500 feet and show only the existing 65 dB 1975 contour. Because of the small scale the 1990 65 dB contours would vary from 1/16 of an inch wider on each side to that shown for 1975. Information on these maps is plotted directly from maps prepared by Cal Trans and BART. The BART noise contours are shown in constant width only to identify the location of the impacted area. The noise contours vary significantly and are only relevant at the large scale originals on file with BART.

Some of the areas where data is lacking are: Highway 84 between Sunol and Livermore and the Livermore Airport. This information will be provided as it becomes available.

[1] The complete background data showing greater detail is available at the Alameda County Planning Department, 399 Elmhurst Street, Hayward.

INDEX MAP OF NOISE ELEMENT MAPS
ALAMEDA COUNTY PLANNING DEPARTMENT
1975 no scale



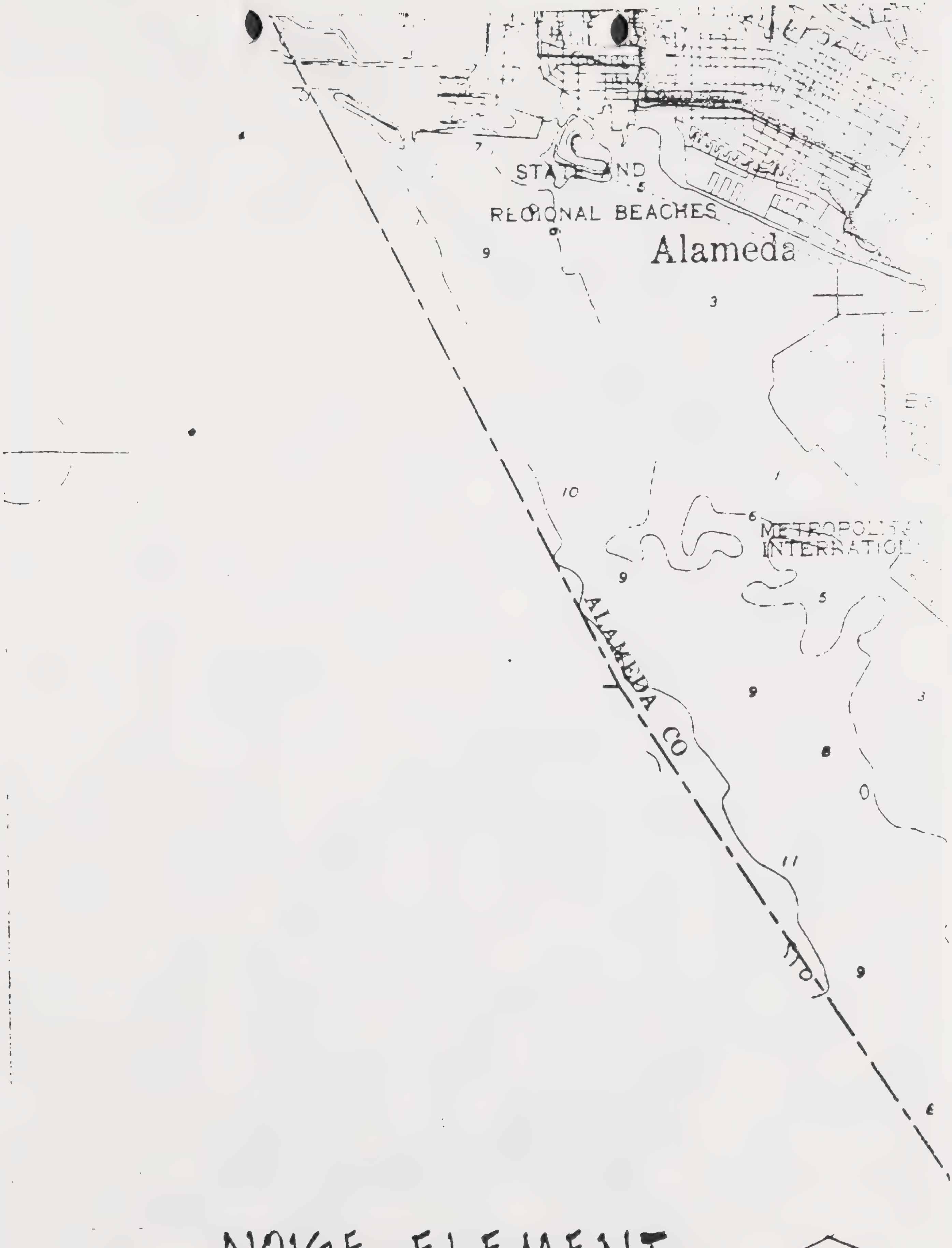


NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65 db_{L-10} SCALE: 1" = 1mile

CALIF. DEPT. OF TRANSPORTATION



NOISE ELEMENT

ALAMEDA COUNTY
SOURCE: 1975 - 65 db_{L-10} SCALE: 1" = 1 mile
CALIF. DEPT. OF TRANSPORTATION

4-13c

North

NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65db L-10 SCALE: 1" = 1mile

CALIF. DEPT. OF TRANSPORTATION

4-13d

North

3

NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65 db$_{L-10}$ SCALE: 1" = 1mile

CALIF. DEPT. OF TRANSPORTATION

North

4

NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65 db_{L-10} SCALE: 1" = 1 mile

CALIF. DEPT. OF TRANSPORTATION

4-13f

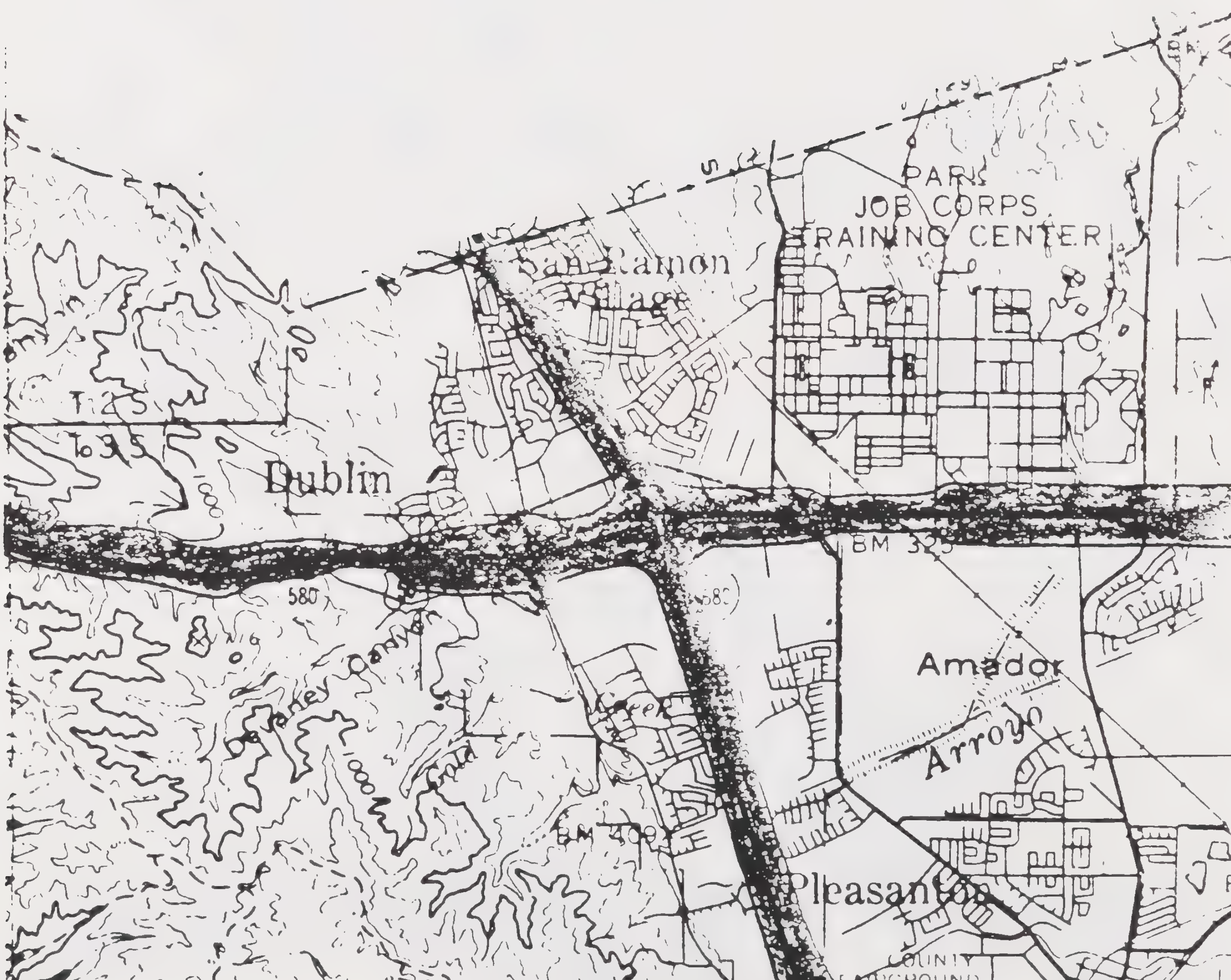
5

NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65db L-10 SCALE: 1" = 1mile 4-138 North 6

CALIF. DEPT. OF TRANSPORTATION



NOISE ELEMENT

ALAMEDA COUNTY

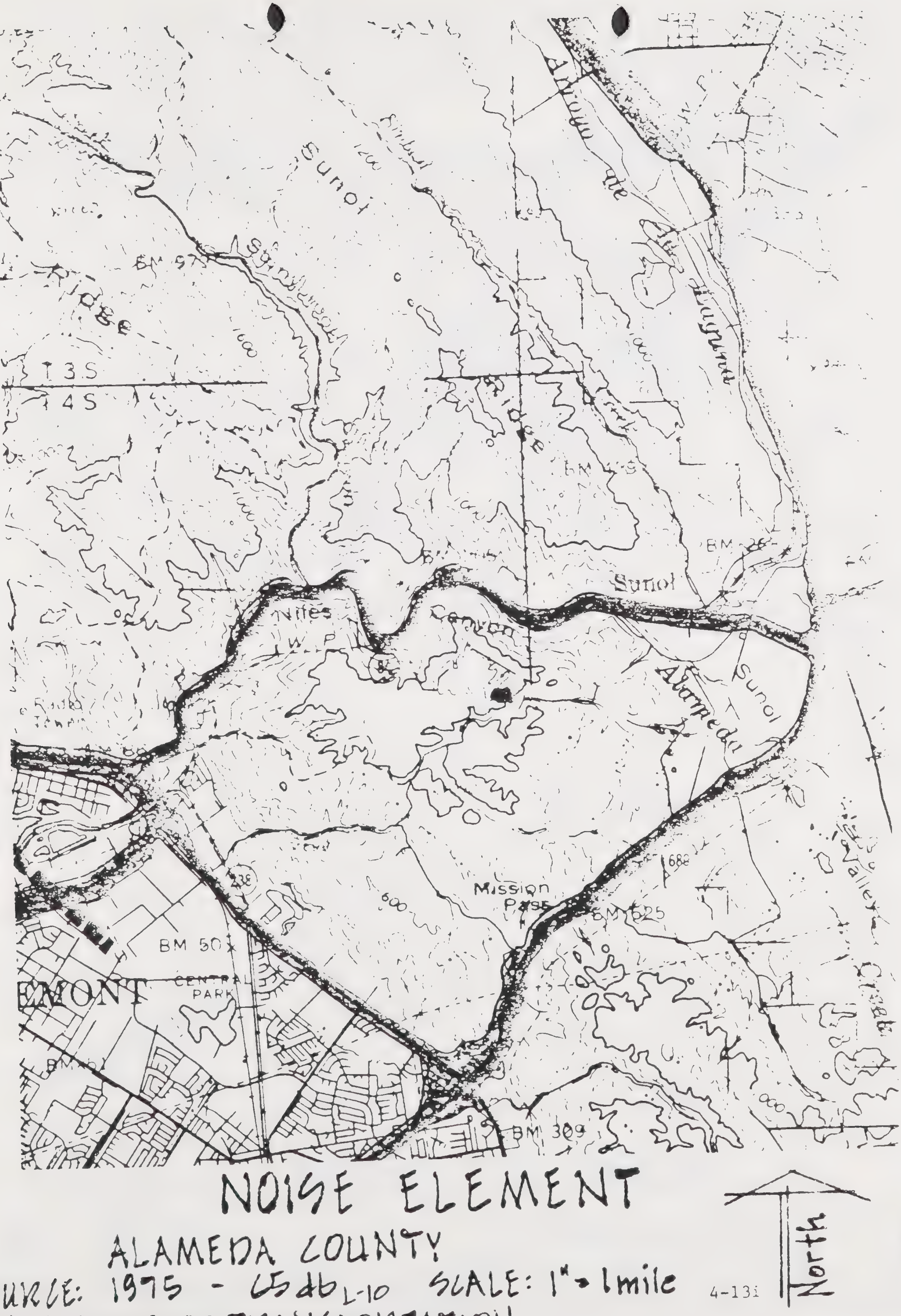
SOURCE: 1975 - 65db$_{L-10}$ SCALE: 1" = 1mile

CALIF. DEPT. OF TRANSPORTATION

North

7

4-13h



NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65db$_{L-10}$ SCALE: 1" = 1 mile

CALIF. DEPT. OF TRANSPORTATION

6

NOISE ELEMENT

ALAMEDA COUNTY

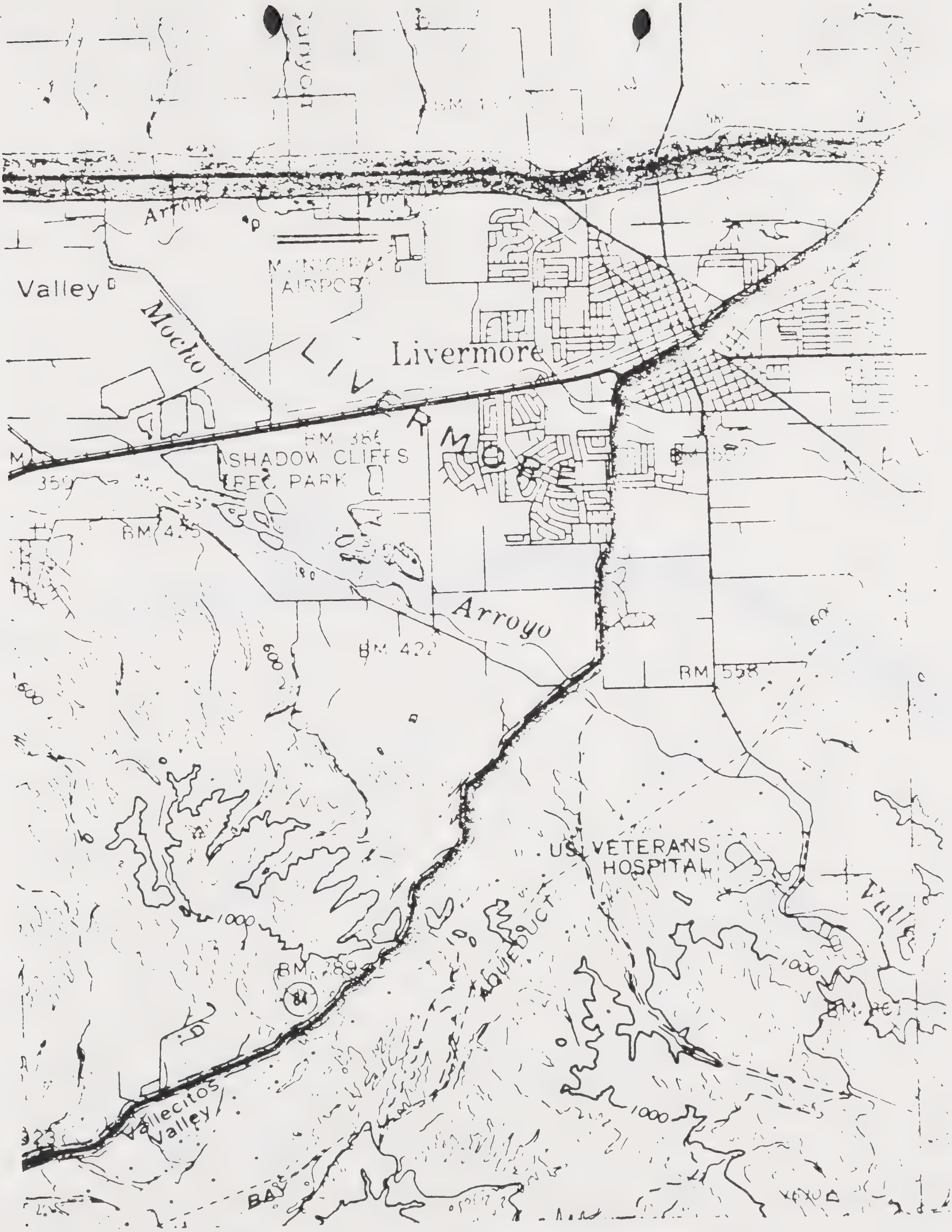
SOURCE: 1975 - 65 db_{L-10} SCALE: 1" = 1 mile

CALIF. DEPT. OF TRANSPORTATION

4-13j

North

9



NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65 db$_{L-10}$ SCALE: 1" = 1 mile

CALIF. DEPT. OF TRANSPORTATION

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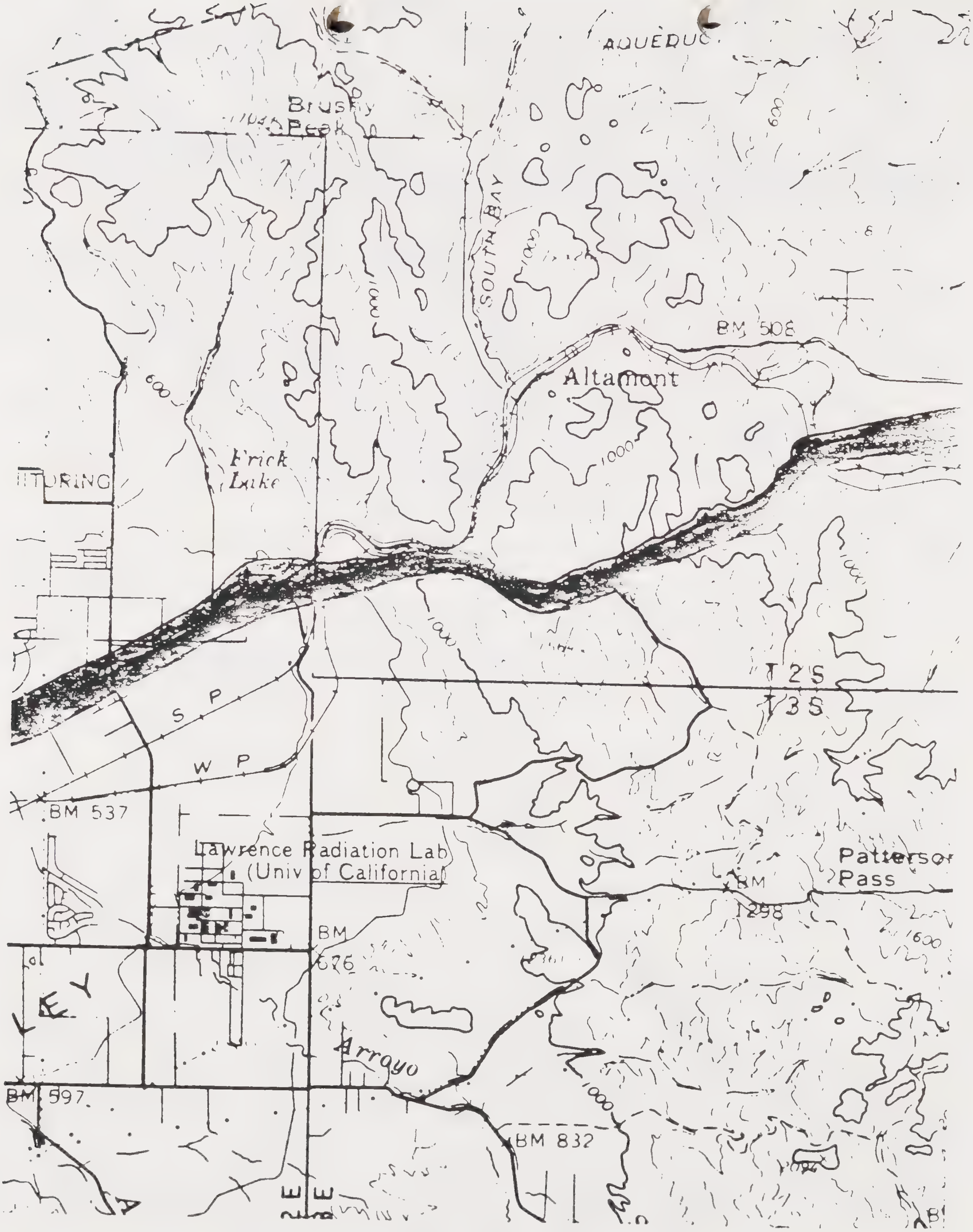

NOISE ELEMENT

ALAMEDA COUNTY

URCE 1975 - 65 db_{L-10} SCALE: 1" = 1mile

LIF. DEPT. OF TRANSPORTATION

North

11

NOISE ELEMENT

ALAMEDA COUNTY

SOURCE: 1975 - 65 db_{L-10} SCALE: 1" = 1 mile

CALIF. DEPT. OF TRANSPORTATION

North

12

Because noise is a type of environmental pollution which has detrimental effects on human health, it is a responsibility of all levels of government to control undesirable noise. Local government can discourage the development of noise sensitive land uses-homes, schools, hospitals, libraries, rest homes, etc - in highway noise impacted areas, or local government can ensure that any development which occurs is planned to minimize the adverse effects of noise.

A major planning consideration is the compatibility of land uses with respect to noise. Users of residential land are sensitive to noise, while users of industrial and agricultural land are less sensitive, for example, there are two basic types of methods available for the prevention of noise incompatible with land use: (1) the physical techniques which reduce noise impacts, and (2) the administrative methods available to local governments to encourage their use.

1. Physical Techniques: Architectural designers, developers and builders can employ acoustical site planning, acoustical architectural design, acoustical construction methods, and barrier construction.

   "Acoustical site design uses the arrangement of buildings on a tract of land to minimize noise impacts by capitalizing on the sites natural shape and contours. Open space, non-residential land uses, and barrier buildings can be arranged to shield residential areas or other noise sensitive activities from noise, and residences can be oriented away from noise".

   "Acoustical architectural design incorporates noise reducing concepts in the details of individual buildings. The areas of architectural concern include building height, room arrangement, window placement, and balcony and courtyard design.

   "Acoustical construction involves the use of building materials and techniques to reduce noise transmission through walls, windows, doors, ceilings, and floors. This area includes many of the new and traditional (soundproofing) concepts.

   "Noise barriers can be erected between noise sources and noise-sensitive areas. Barrier types include beams made of sloping mounds of earth, walls and fences constructed of a variety of materials, thick plantings of trees and shrubs, and combinations of these materials."[1]

2. Administrative Techniques: Administrative techniques to ensure that physical methods of noise minimization are implemented may be categorized into five groups: (1) zoning; (2) legal restrictions such as subdivision control, building and health codes; (3) public ownership or control of the land; (4) financial incentives for compatible development; and (5) educational and advisory services.

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[1] Urban Systems Research and Engineering, Inc. for U.S. Department of Transportation, The Audible Landscape: A Manual for Highway Noise and Land Use (November, 1974), p.34.

While certain land uses are associated with higher noise levels (quarry, industrial, commercial, circulation), areas within a community which suffer from excessive noise may not coincide with traditional zoning districts. As a result, a method to define the areas where acoustical regulations could apply needs to be investigated. Zoning specifications could be applied to newly created noise impacted zones or to a single "overlay zone" which is superimposed over regular zoning.

> "Zoning can be used in four ways to insure that future development will be compatible with nearby noise sources:
> 1. by exclusion of typically incompatible uses from noise impacted areas,
> 2. by regulating specific details of development design or construction,
> 3. by permitting, special development techniques such as cluster and planned unit development which enable noise compatible site design, and
> 4. by defining the areas of applicability of other local regulations."[1]

Noise compatible land use controls also include other ordinances besides zoning. Subdivision ordinances can require acoustical site planning of the development or noise barrier construction. Building codes may specify construction techniques and details (such as insulation and sealed windows). Health codes may establish noise level standards for habitable buildings. If they are exceeded, the building can be declared uninhabitable, or local laws may require that an occupancy permit be received before a building can be used. The individual review of each building application is a special permit procedure which can be included in the zoning ordinance or the general city/county ordinance code. Also, the environmental impact review process could include noise impacts of the project which would require site-specific acoustical analysis.

If the local government owns the noise-impacted land, it could keep the land vacant or develop it with noise compatible land uses. Financial incentives to deal with noisy areas could include assessing undeveloped and underdeveloped land at a low rate, reducing pressures on landowners to sell because of high property taxes. Government could also provide, at low cost, information concerning noise compatibility measures to builders, developers, architects, and the general public.

Another planning consideration is the abatement of highway and circulation noise. Noise created by highway traffic permeates communities quite distant from the highway. Community noise levels are controlled or influenced by noise from one or more highways within a certain distance and by single-vehicle noise from immediately adjacent streets. While trucks are the greatest source of highway noise, motorcycles and sports cars can be as noisy as trucks and are often judged by the public to be even more annoying. The way in which these vehicles are operated is

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1 Urban Systems Research and Engineering, Inc., for U. S. Department of Transportation, The Audible Landscape: A Manual for Highway Noise and Land Use (November, 1974), p. 11.

a particular problem and accounts for much of the noise problem on both highways and local streets. Thus, highway and land use planners can curtail the noise from traffic that adversely affects sensitive land uses by constructing barriers, elevating or depressing highways, regulating speed limits, limiting access of certain vehicles to particular routes by time of day, and providing for compatible use of land adjacent to highways and expressways.

While a noise ordinance has little or no effect on controlling the compatibility of land uses constructed in areas where noise exists, it can have a significant effect in reducing noise at its source if it is well-written and enforced. Alameda County does not have a noise ordinance, but standards and limitations concerning acceptable levels of noise are prescribed in the Building Code and Zoning Ordinance. The Zoning Ordinance sets performance standards with respect to exterior levels of noise on industrial properties. No discernable noise from an industrial (M) district is to impinge on adjacent residential (R) districts. The County Zoning Ordinance also places restrictions on noise levels at quarries and car washes. Within residential districts, home occupation noise is restricted. Enforcement of a community noise ordinance could be assigned to the police, building inspectors, and/or environmental control officers.

V. COUNTYWIDE POLICIES

Goal #1: The peace, health, safety, and welfare of the residents of Alameda County require protection from excessive, unnecessary, and unreasonable noises from any and all sources in the cities and unincorporated territory.

Goal #2: Promote the compatibility of land uses with respect to noise generation by legislatively protecting sensitive land uses from noise sources.

Objective #1: Investigate and implement physical and legislative techniques to reduce noise impacts where appropriate.

Principle #1: Community noise control standards which establish maximum permitted noise levels for sensitive land uses-residential, community care facilities (hospitals, nursing homes, etc.), schools, and any other use considered by the community to be sensitive to noise should be developed and implemented by each jurisdiction.

Principle #2: Local govenments in cooperation with transportation agencies should promote the abatement of highway, circulation, aircraft,and rapid transit noise.

Principle #3: Local governments should exercise significant authority in controlling the noise problem because they have the responsibility for land development control and zoning.

VI. UNINCORPORATED AREA POLICIES

Goal #1: Alameda County should provide its residents and wildlife with an environment which is free from excessive noise pollution by preventing and suppressing undesirable levels, frequencies, and time durations of noise.

Goal #2: Alameda County should encourage noise compatible land uses near highways and other noise generators.

Objective #1: In order to control objectionable noise, Alameda County should survey noise sources and impacts in the unincorporated area and develop acceptable noise level standards for noise impacted areas.

Objective #2: The County should seek to develop regional planning agreements for zoning and soundproofing to reduce noise incompatibilities across jurisdictional boundaries.

Objective #3: The County should examine existing County ordinances and regulations to determine the effectiveness of existing controls and where additional performance standards are needed to reduce noise problems.

Objective #4: Alameda County should develop and adopt a County Noise Ordinance to prohibit unwanted and unnecessary sounds of all types within the unincorporated territory.

Objective #5: The County should encourage architectural designers, developers, and builders to employ physical techniques to reduce noise impacts.

Objective #6: The public should be informed of the significant financial and social costs of noise incompatibilities.

XII. IMPLEMENTATION PROGRAM, UNINCORPORATED AREA

1. Problem Identification:

   a. Continue to study existing noise problems in the unincorporated communities. Collect data on ambient noise levels, source noise levels, and frequency of occurrence.

   b. Survey public attitudes toward noise in order to determine desirable noise levels and to further define noise compatibility goals.

   c. Study potential noise incompatibilities and potential land uses in noise impacted areas.

2. Preventing and Minimizing Noise Impacts:

   a. Examine the existing administrative structure to determine which administrative techniques are most desirable for implementing physical solutions to minimize noise. These techniques include zoning; subdivision, building, and health codes; public ownership of land; financial incentives; and advisory services.

   b. Develop and adopt a County Noise Ordinance to prevent unwanted and excessive sound. The ordinance would contain the County's philosophy toward noise and standards, such as residential property noise limits, to prevent noise.

c. Contact state and federal officials to convey the County's concern over noise problems beyond the County's immediate control, i.e. source emission reduction on highways and improved highway design.

d. Require environmental impact reports for proposed projects to include an examination of anticipated noise impacts.

3. Study of Legal Status:

a. Examine legal limitations on powers of County government to restrict and regulate land use control. Not all of the desirable physical solutions may be possible under existing administrative structures.

4. Public Participation:

a. Increase public awareness of noise incompatibility in the County.

b. Examine local traditions and attitudes toward noise compatibility control techniques.

5. City-County Coordination:

a. Continue liason with the cities and investigate methods to reduce noise problems across city-county boundaries.

GLOSSARY

AIRBORNE SOUND. Sound that reaches the point of interest by propagation through air.

AMPLITUDE. Peak value of a periodically varying quantity such as traveling sound wave.

ATTENUATION. A reduction in strength,effect, or amplitude of a sound.

A-WEIGHTING NETWORK (A-Scale). The ear does not respond equally to sounds of all frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dBA. The A-weighted sound level is also called the noise level. Sound level meters have an A-weighting network for measuring A-weighted sound level.

COMMUNITY NOISE EQUIVALENT LEVEL (CNEL). A scale which takes account of all the A-weighted acoustic energy received at a point, from all noise events causing noise levels above some prescribed value. Weighting factors are included which place greater importance upon noise events occurring during the evening hours (7:00 p.m. to 10:00 p.m.) and even greater importance upon noise events at night (10:00 p.m. to 6:00 a.m.).

CONTINOUS NOISE. On-going noise whose intensity remains at measurable level (which may vary) without interruption over an indefinite period or a specified period of time.

DEAFNESS. 100 percent impairment of hearing associated with an organic condition. Note: This is defined for medical and cognate purposes as the hearing threshold level for speech or the average hearing threshold level for pure tones of 500, 1000 and 2000 Hz in excess of 92 dB.

DECIBEL. A unit measure of sound (noise) level relative to a standard reference sound on a logarithmic scale. The quantity "zero decibels" corresponds to the sound pressure level of the least powerful sound --the standard reference sound —that a very sensitive human ear can hear. (This standard reference sound has a sound pressure level which is .00002 times atmospheric pressure.)

ENVIRONMENTAL NOISE. By Sec.3(11) of the Noise Control Act of 1972, the term "environmental noise" means the intensity, duration, and character of sounds from all sources.

FREQUENCY. The number of oscillations per second of a sine-way of sound; now expressed in Hertz (Hz),formerly in cycles per second (cps).

L10 (level). The noise level that is exceeded for 10% of any specific sampling time.

NOISE EXPOSURE FORECAST (NEF). A scale (analogous to CNEL) which has been used by the Federal government and other agencies in land use planning guides for use in connection with airports. The noise exposure level at a point expressed in the NEF scale is numerically about 35 dB lower than if expressed in the CNEL scale.

NOISE LEVEL CONTOURS. Noise sources such as airports and trafficways generate a noise environment which can be described by drawing contours on a map. The contour lines connect the points on a land surface map that have the same noise level. and are analogous to lines of equal elevation on a topographic map.

SOUND EXPOSURE LEVEL. The level of sound accumulated over a given time interval or event. Technically,the sound exposure levels is the level of the time integrated mean square A-weighted sound for a stated time interval or event, with a reference time of one second.

SOUND LEVEL. The quantity in decibels measured by a sound level meter satisfying the requirements of American National Standards Specification for Sound Level Meters S1.4-1971. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A, B or C; unless indicated otherwise, the A-weighting is understood. The unit of any sound level is the decibel, having the unit symbol dB.

SOUND LEVEL METER. An instrument, comprising a microphone, an amplifier, an output meter, and frequency-weighting networks, that is used for the measurement of noise and sound levels.

SOUND PRESSURE LEVEL. The variation from atmospheric pressure caused by a sound wave. (Expressed mathematically, the sound pressure level of a sound in question is, in decibels, 20 times the logarithm to the base 20 of the ratio of the pressure of the sound in question to the reference pressure, where the reference pressure is .00002 times atmospheric pressure.) Generally, the greater the sound pressure, the louder the sound.

APPENDIX A

TERMINOLOGY FOR COMMUNITY NOISE CNEL AND L_{dn}[1]

Community Noise Equivalent Level (CNEL)

The following simplified expressions are derived from the exact definitions in the report, "Supporting Information for the Adopted Noise Regulations for California Airports." They can be used to estimate values of CNEL where one type of aircraft and one flight path dominate the noise exposure level.

Single event noise is specified by the single event noise exposure level (SENEL) in dB and can be closely approximated by:

$$SENEL = NL_{max} + 10 \log t_{ea}, \quad dB$$

where

NL_{max} = maximum noise level as observed on the A scale of a standard sound level meter

and

t_{ea} = effective time duration of the noise level (on A scale) in seconds

The effective duration is equal to the "energy" of the integrated noise level (NL), divided by the maximum noise level, NL_{max}, when both are expressed in terms of antilogs. It is approximately 1/2 of the 10 dB down duration, which is the duration for which the noise level is within 10 dB of NL_{max}.

A measure of the average integrated noise level over 1 hour is also used in the California Airport Noise Regulation. This is the hourly noise level (in dB), defined as:

$$HNL \approx \overline{SENEL} + 10 \log n - 35.6, \ dB$$

where

$\overline{SENEL}$ = energy mean value of SENEL for each single event,

and

n = number of flights per hour

The total noise exposure for a day is specified by the community noise equivalent level (CNEL) in dB, and may be expressed as:

Source: American Standard Acoustical Terminology, S1.1-1960, Revision of Z24.1-1951 and including Z24.1a, American Standards Association, May 26, 1960.

$$CNEL = \overline{SENEL} + 10 \log N_c - 49.4, \text{ dB}$$

where

$$N_c = (N_d + 3N_e + 10N_n)$$

or

$$= (12\,\overline{n}_d + 9\,\overline{n}_e + 90\,\overline{n}_n)$$

$N_d, \overline{n}_d$ = total number and average number per hour, respectively, of flights during the period 0700 to 1900

$N_e, \overline{n}_e$ = total number and average number per hour, respectively, of flights during the period 1900 to 2200

and

$N_n, \overline{n}_n$ = total number and average number per hour, respectively, of flights during the period 2200 to 0700

Day-Night Average Level (L_{dn})

A new composite noise scale is currently under consideration by the Environmental Protection Agency for specification of community noise from all sources. Called Day-Night Average Level, it is nearly the same as CNEL except that the weighting for the evening time period in CNEL is eliminated and the "day" extends from essentially 7 a.m. to 10 p.m. while the "night," with a 10 dB weighting penalty, extends from 10 p.m. to 7 a.m.

Defined in the approximate manner as above,

$$L_{dn} \simeq \overline{SENEL} + 10 \log N_e - 49.4$$

where

$$N_e = N_d' + 10\,N_n$$

N_d' = total number of events (flights) during the daytime (0701 to 2200)

N_n = total number of events (flights) during the nighttime (2201 to 0700)

$\overline{SENEL}$ = energy mean value of SENEL for each single event

When defined in the more general way for application to continuous monitoring of community noise, L_{dn} would be given by

$$L_{dn} = 10 \log \left[\frac{15}{24} \cdot \log^{-1}\left(\frac{\overline{L}_d}{10}\right) + \frac{9}{24} \cdot \log^{-1}\left(\frac{\overline{L}_n + 10}{10}\right) \right]$$

where

$\overline{L_d}$ = energy mean A-weighted noise level during the daytime (0701 to 2200)

$\overline{L_n}$ = energy mean A-Weighted noise level during the nighttime (2201 to 0700)

$\log^{-1}$ denotes an inverse logarithm

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